A Compact Fluorescence Lifetime Excitation-Emission Spectrometer (FLEXEMS) for Detecting Trace Organics, Phase II

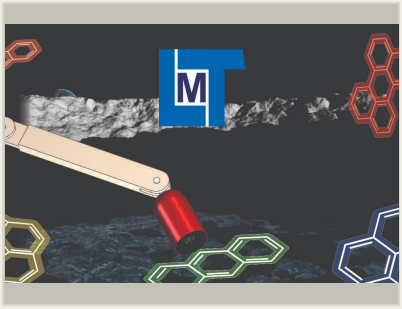
Completed Technology Project (2017 - 2022)

Project Introduction

In this Small Business Innovative Research (SBIR) effort, Leiden Measurement Technology (LMT) proposes to design and build the Fluorescence Lifetime Excitation Emission Spectrometer (FLEXEMS), a stand-off fluorescence spectrometer that uses multiple light-emitting diodes to excite fluorescence in samples from the deep-ultraviolet through the visible and employs time-correlated single-photon counting (TCSPC) and steady-state photon-counting techniques to quantify the fluorescence properties of the target in order to detect and identify trace levels of organics in-situ. The addition of fluorescence lifetime measurements distinguishes it from other compact, field-portable instruments available. For typical use, the instrument will require no reagents or consumables and by simply placing the instrument on a sample of rock, soil, or ice, or other material it will be able to detect a wide range of organics (at or below the 10-100 ppb-level) including free aromatic amino acids; biomarkers including F420 (specific to methanogens), NADH, and proteins; PAHs; and porphyrins (e.g. chlorophyll). It will be designed with flight in mind so that mass, volume, and power-usage will be minimized as much as possible.

Anticipated Benefits

A flight version of FLEXEMS could be used on nearly any NASA mission that has Life Detection or the more general detection and identification of organics as one of its goals. Because FLEXEMS is inherently a stand-off instrument requiring no consumables, it requires no complicated sample-handling under most situations and can take a variety of different form-factors to suit the mission architecture: flow-through measurements of extraterrestrial water or melted ices implemented in microfluidic packaging; surface measurements of ices or minerals; integrated into optical microscopes; etc. Because FLEXEMS requires no consumables, it could be used indefinitely making it especially well-suited for long-duration missions where it could serve as both a primary instrument or a triage instrument for other instruments that may have a limited number of uses. Target extraterrestrial bodies FLEXEMS would be ideal to explore include Europa, Enceladus, comets and asteroids, Mars, and the permanently-shadowed craters of Moon. Additionally, its miniature size makes it suitable for Small- Sat missions to study organics such as O/OREOS. For terrestrial use, it will allow researchers in NASA's Space Science and Astrobiology Division to quantify the presence of different minerals and organics during analog field research and laboratory research and can integrate well into the NASA Ames Astrochemistry Facility.FLEXEMS has many uses outside of NASA. Due to its sensitivity, specificity, and portability, it would be very useful for (1) environmental research of terrestrial and marine waters (e.g., DOM, humic and fulvic acid studies, aromatic pollutants), (2) process control and monitoring of closed and recycled water systems (e.g., Naval or cruise shipboard water monitoring, water treatment, municipal water recycling plants), (3) pollution monitoring of water, soils and sediments (e.g.,



A Compact Fluorescence Lifetime Excitation-Emission Spectrometer (FLEXEMS) for Detecting Trace Organics, Phase II Briefing Chart Image

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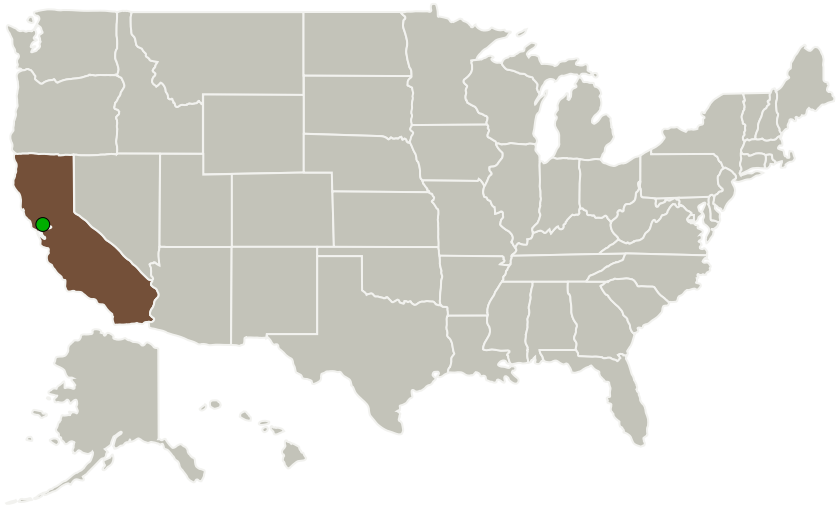
BTEX, PAHs, pesticides, and fuels), (5) the detection of biological weapons (e.g., Anthrax). Considering only (1) and (2), it is anticipated that total 5-year revenue may be as high as $20M.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Leiden Measurement Technology, LLC	Lead Organization	Industry	Sunnyvale, California
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Leiden Measurement Technology, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:

Christine M Martinez
Ryszard L Pisarski

Principal Investigator:

Nathan E Bramall

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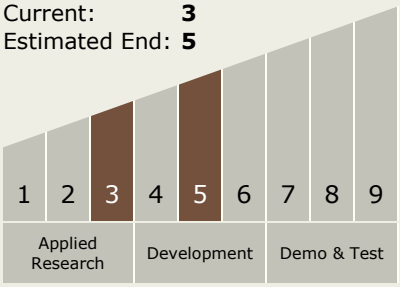
Images

Briefing Chart Image
A Compact Fluorescence Lifetime Excitation-Emission Spectrometer (FLEXEMS) for Detecting Trace Organics, Phase II Briefing Chart Image
(https://techport.nasa.gov/image/131275)

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **5**



Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System